US009057990B2

(12) **United States Patent**
Yamaguchi

(10) **Patent No.: US 9,057,990 B2**
(45) **Date of Patent: Jun. 16, 2015**

(54) **IMAGE FORMING APPARATUS**

(71) Applicant: **Wataru Yamaguchi**, Nisshin (JP)

(72) Inventor: **Wataru Yamaguchi**, Nisshin (JP)

(73) Assignee: **Brother Kogyo Kabushiki Kaisha**, Nagoya-shi, Aichi-ken (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 84 days.

(21) Appl. No.: **13/835,637**

(22) Filed: **Mar. 15, 2013**

(65) **Prior Publication Data**

US 2013/0315624 A1 Nov. 28, 2013

(30) **Foreign Application Priority Data**

May 25, 2012 (JP) 2012-119849

(51) **Int. Cl.**
G03G 15/08 (2006.01)
G03G 15/16 (2006.01)
G03G 21/16 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/16*** (2013.01); ***G03G 15/1685*** (2013.01); ***G03G 21/168*** (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/0178; G03G 2215/0119; G03G 15/755; G03G 2215/00143; G03G 2221/1642; G03G 15/11; G03G 15/1615; G03G 15/1655; G03G 15/6552; G03G 2215/0016; G03G 2215/0158; G03G 2215/1623; G03G 15/16
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0231003	A1*	10/2007	Shoji	399/121
2009/0202275	A1*	8/2009	Nishida et al.	399/165
2011/0064467	A1	3/2011	Hayakawa	

FOREIGN PATENT DOCUMENTS

JP	2005-321556	A	11/2005
JP	2007-316218	A	12/2007
JP	2010-175689	A	8/2010
JP	2011-064897	A	3/2011

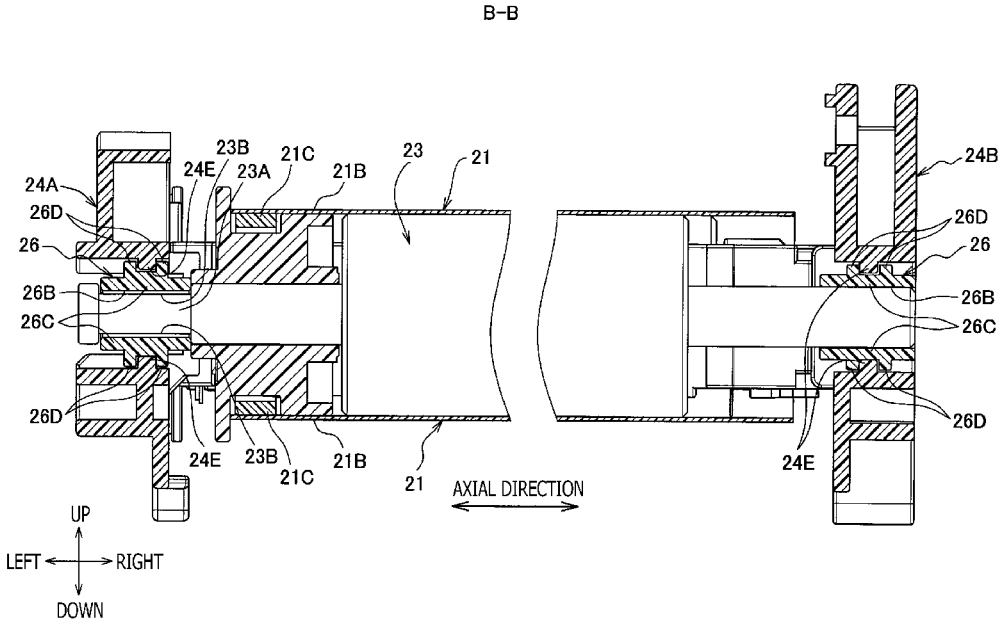
* cited by examiner

Primary Examiner — Roy Y Yi
(74) *Attorney, Agent, or Firm* — Banner & Witcoff, Ltd.

(57) **ABSTRACT**

An image forming apparatus including an image forming unit; a belt unit with a first roller, a second roller, an endless belt, and a frame; a frame positioning member arranged in the belt unit to define a position of the frame in the axial direction with respect to a body; a first roller positioning member arranged in the belt unit to define a position of the first roller in the axial direction with respect to the frame; a guiding member arranged in a position corresponding to one of axial-end sides of the first roller along the axial direction in the endless belt; and an engageable member arranged on the one of axial-end sides of the first roller in the belt unit, is provided. The frame positioning member, the first roller positioning member, and the engageable member are arranged on the same axial-end side along the axial direction.

6 Claims, 10 Drawing Sheets



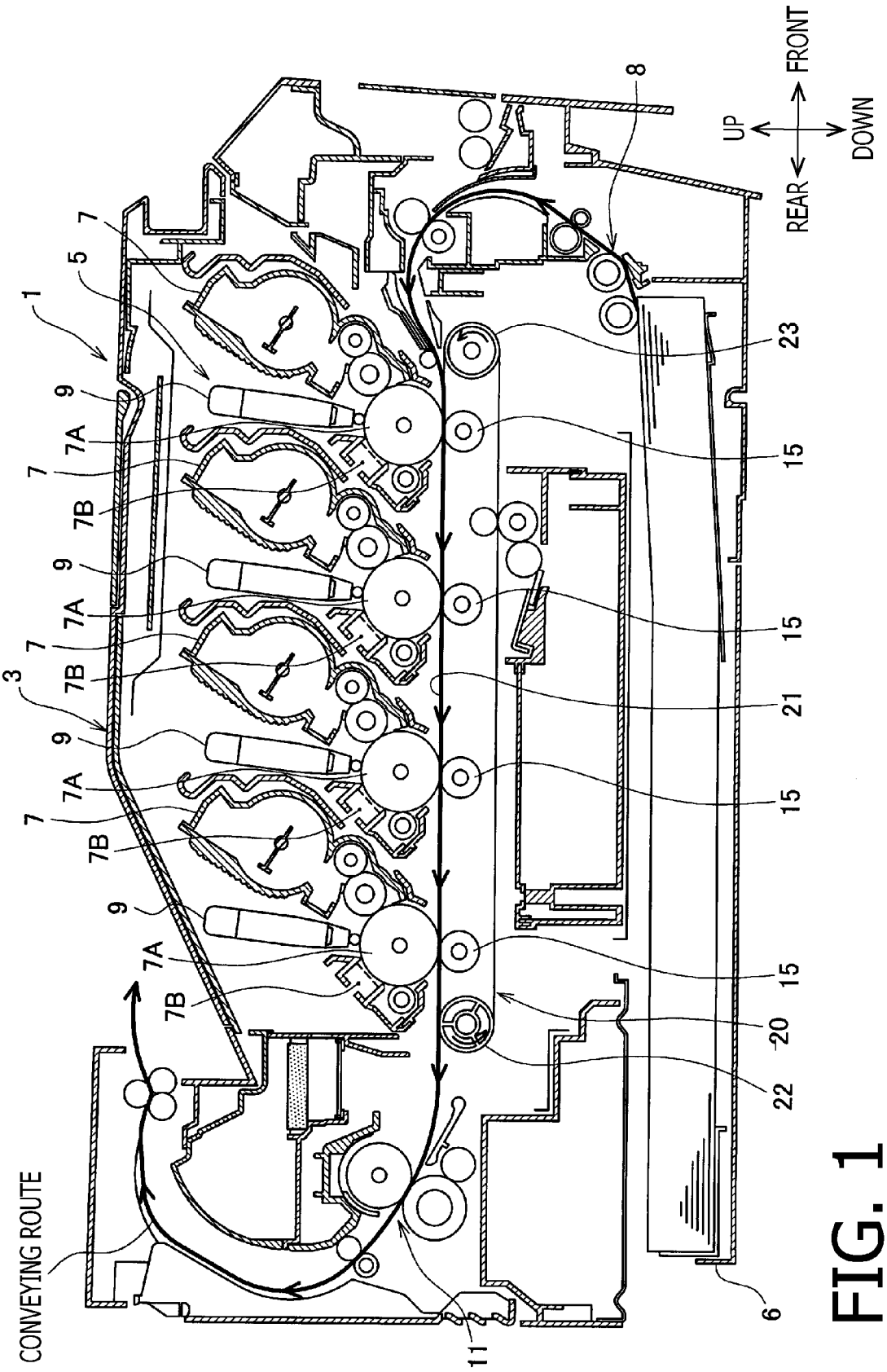

FRONT
REAR
UP
DOWN
CONVEYING ROUTE
1
3
5
6
7
7A
7B
8
9
11
15
20
21
22
23

FIG. 1

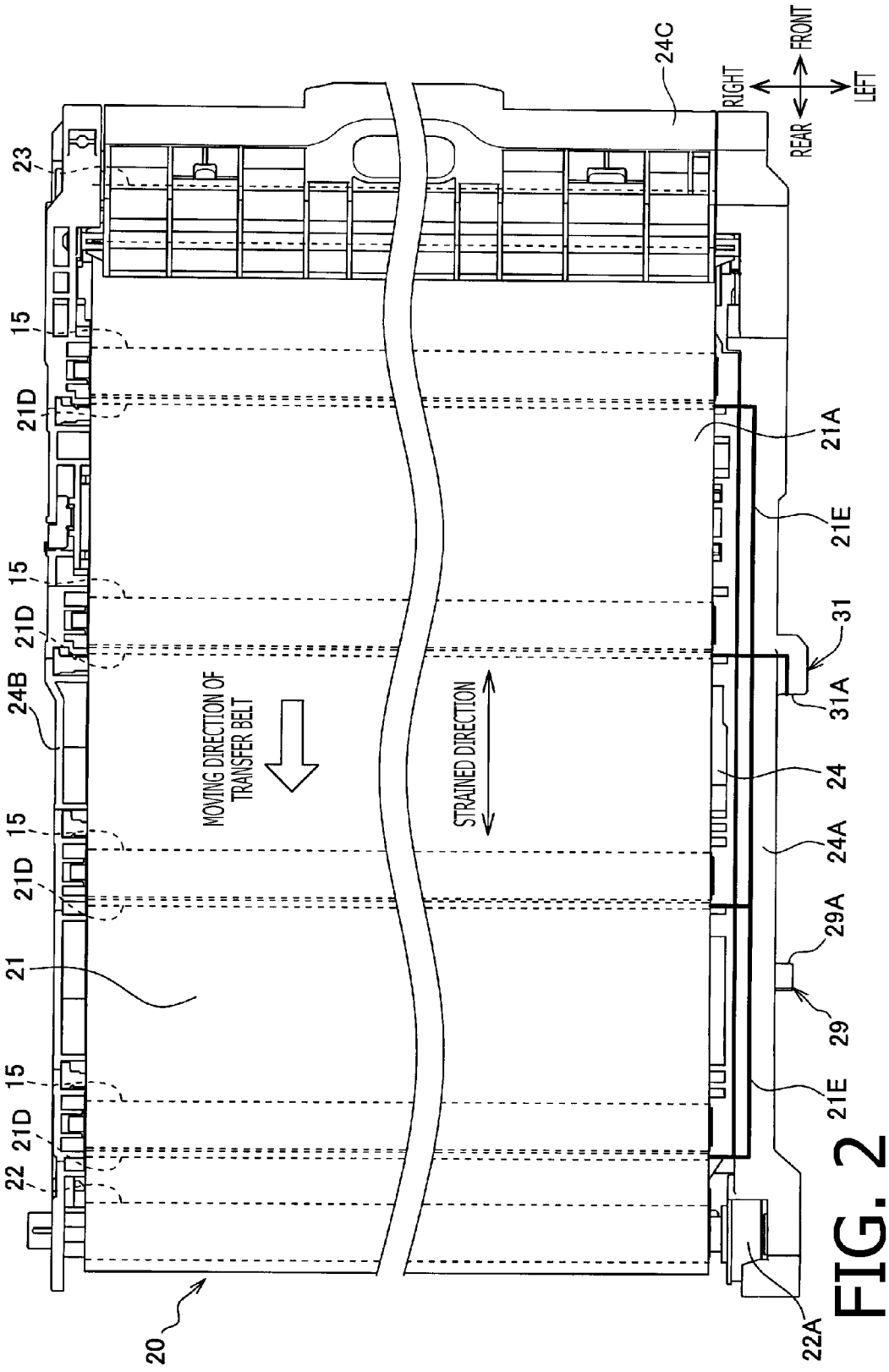

24C
RIGHT
FRONT
LEFT
REAR
23
15
21D
21A
21E
31
31A
24B
MOVING DIRECTION OF TRANSFER BELT
STRAINED DIRECTION
24
24A
29A
29
21
22
22A
20

FIG. 2

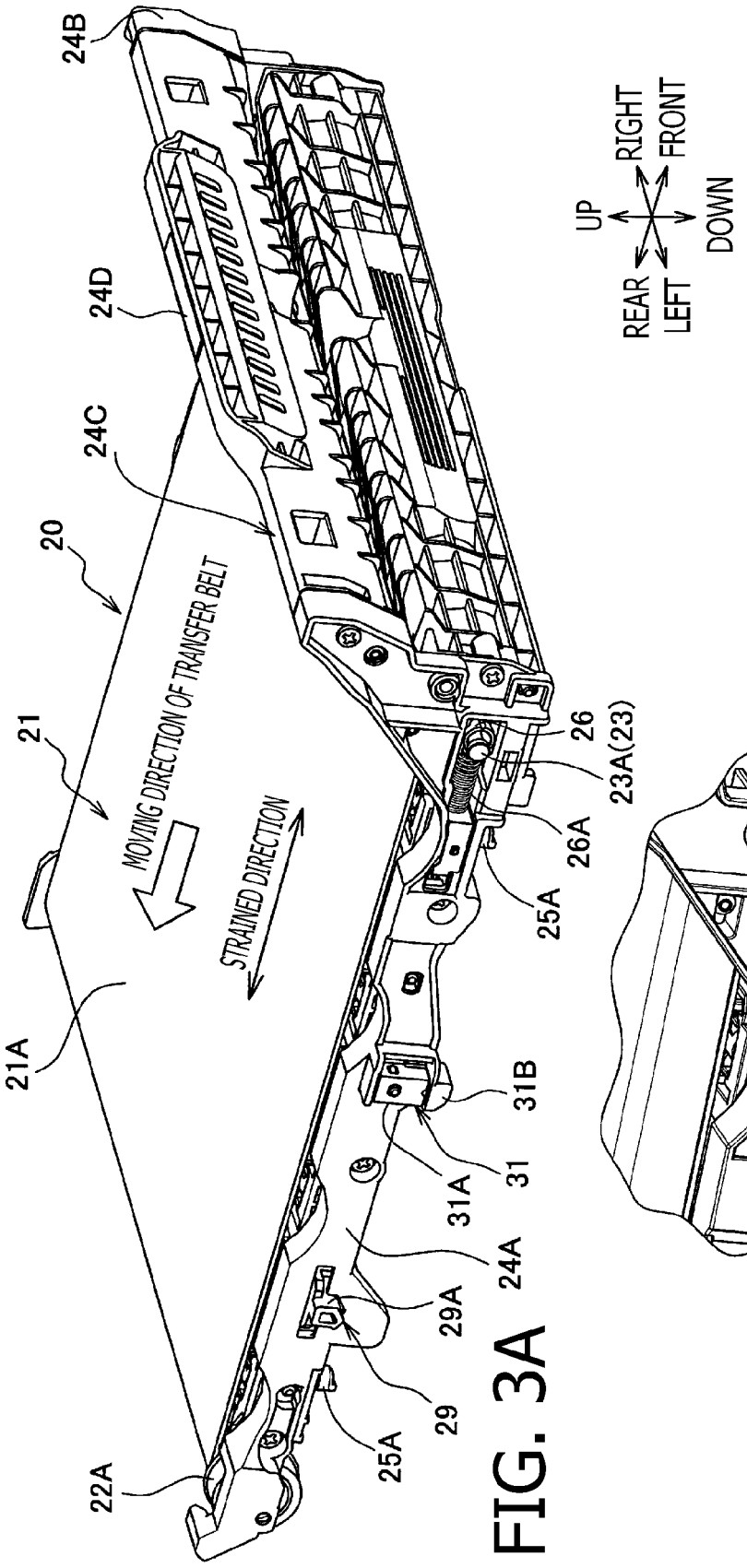

24B
24D
24C
20
21
21A
MOVING DIRECTION OF TRANSFER BELT
STRAINED DIRECTION
22A
25A
29
29A
24A
31A
31
31B
26A
23A(23)
26
UP
RIGHT
FRONT
DOWN
REAR
LEFT

FIG. 3A

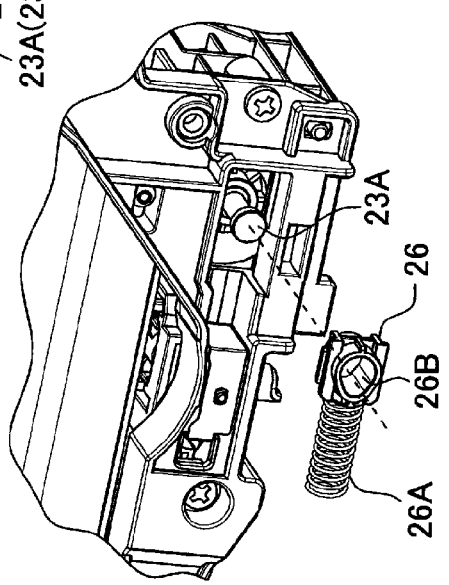

23A
26
26B
26A

FIG. 3B

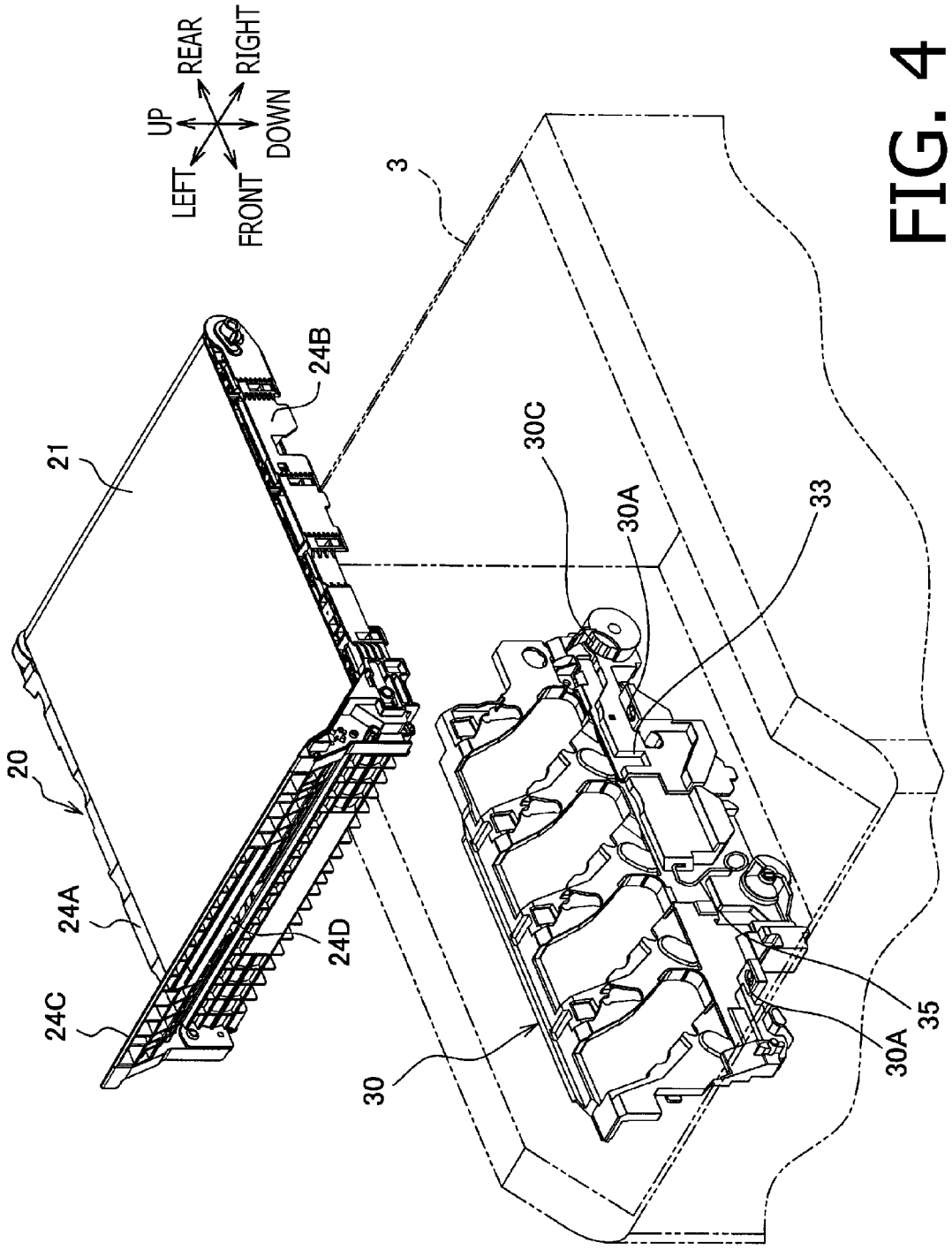

UP
REAR
RIGHT
LEFT
FRONT
DOWN
3
21
24B
30C
30A
33
20
24A
24D
24C
30
35
30A

FIG. 4

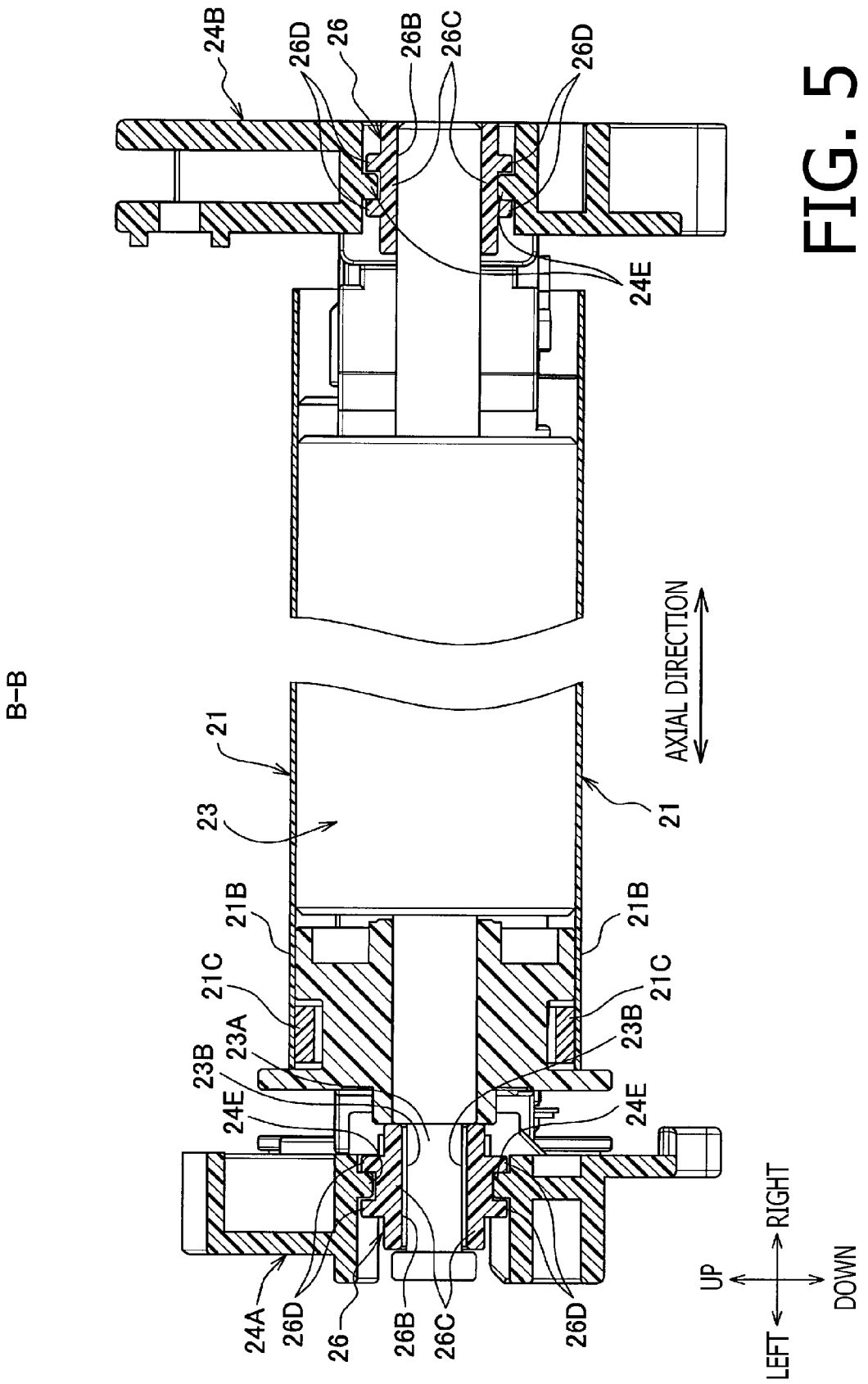

B-B
24B
26D
26
26B
26C
26D
24E
AXIAL DIRECTION
21
23
21
21B
21B
21C
21C
23A
23B
23B
24E
24E
24A
26D
26
26B
26C
26D
UP
RIGHT
DOWN
LEFT

FIG. 5

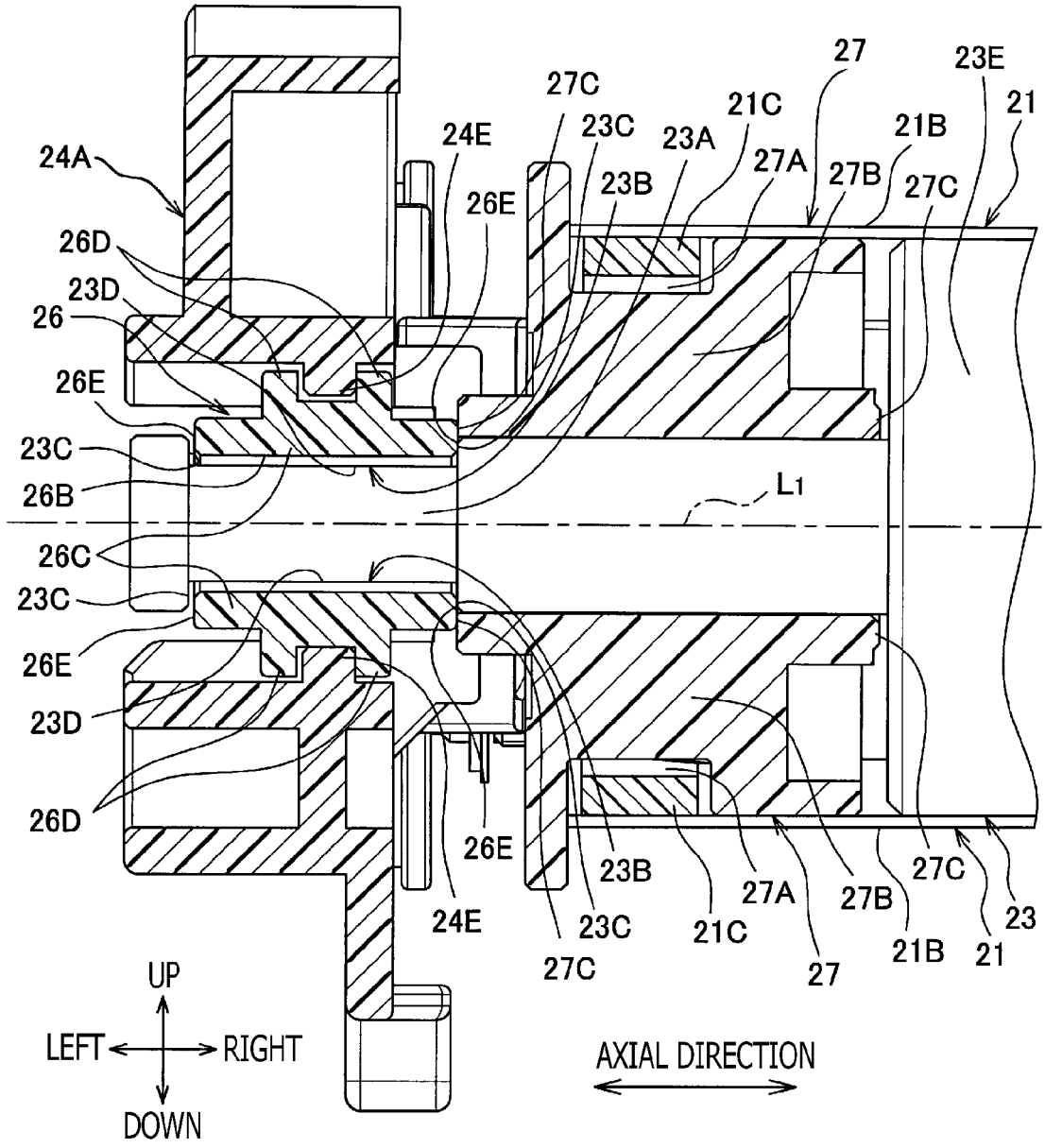

24A
26D
23D
26
26E
23C
26B
26C
23C
26E
23D
26D
27C
24E
26E
23C
23B
23A
21C
27
27A
27B
21B
27C
23E
21
L1
UP
LEFT
RIGHT
DOWN
AXIAL DIRECTION

FIG. 6

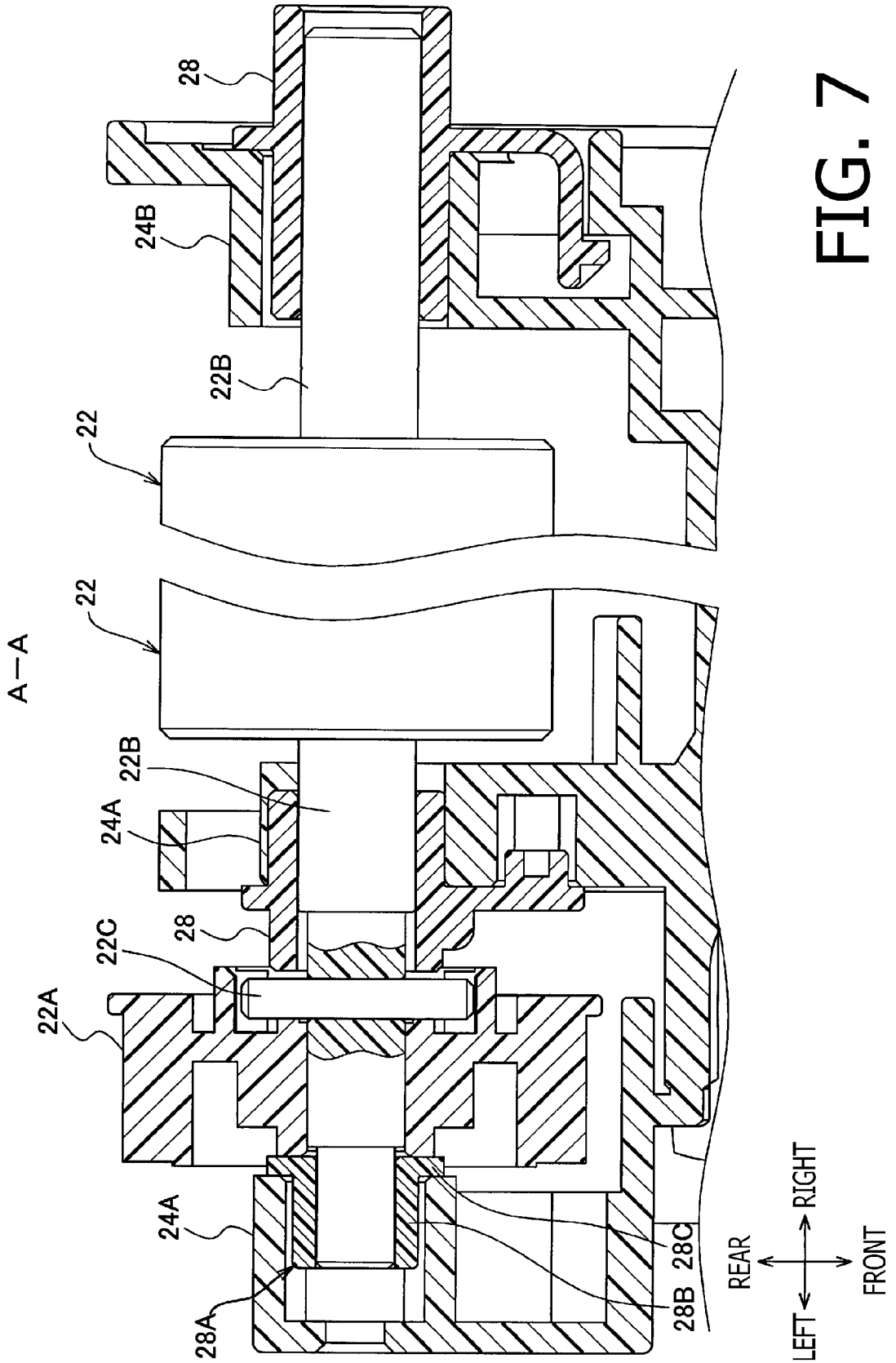

28
24B
22B
22
22
A—A
22B
24A
28
22C
22A
24A
28A
28B
28C
REAR
RIGHT
LEFT
FRONT

FIG. 7

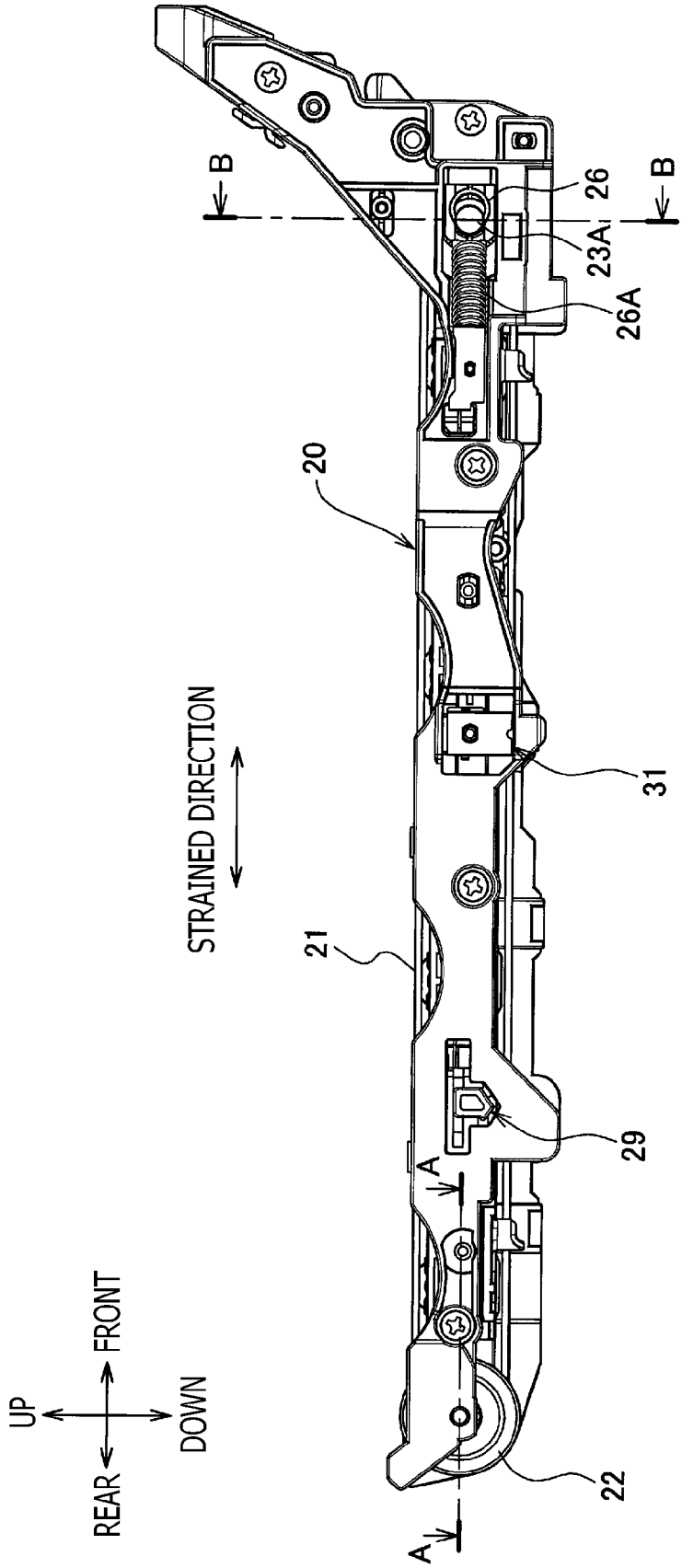

B
B
26
23A
26A
20
STRAINED DIRECTION
31
21
29
A
A
22
UP
FRONT
DOWN
REAR

FIG. 8

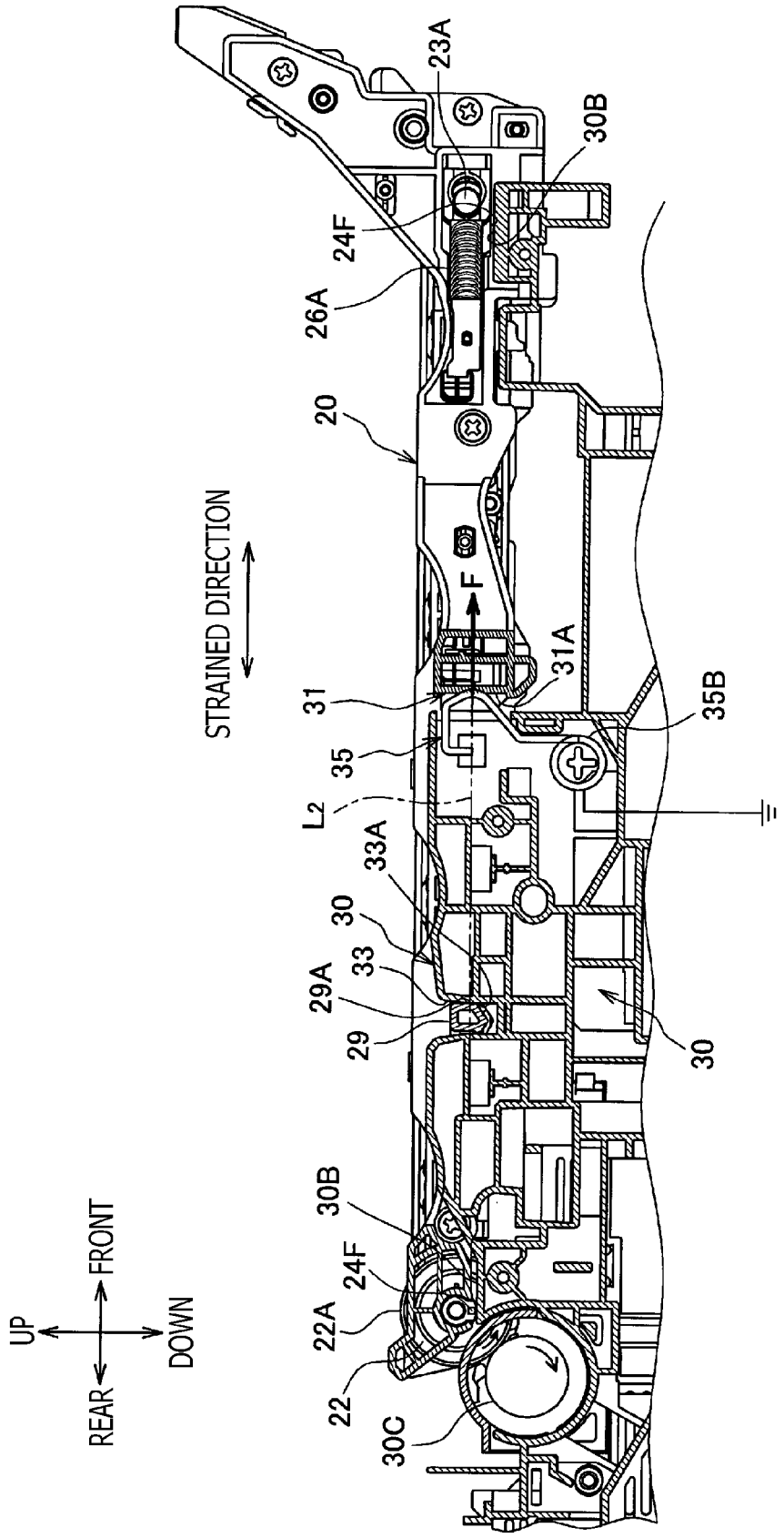

23A
30B
24F
26A
20
STRAINED DIRECTION
F
31A
31
35B
35
L2
33A
30
33
29A
29
30
30B
24F
22A
22
30C
UP
FRONT
REAR
DOWN

FIG. 9

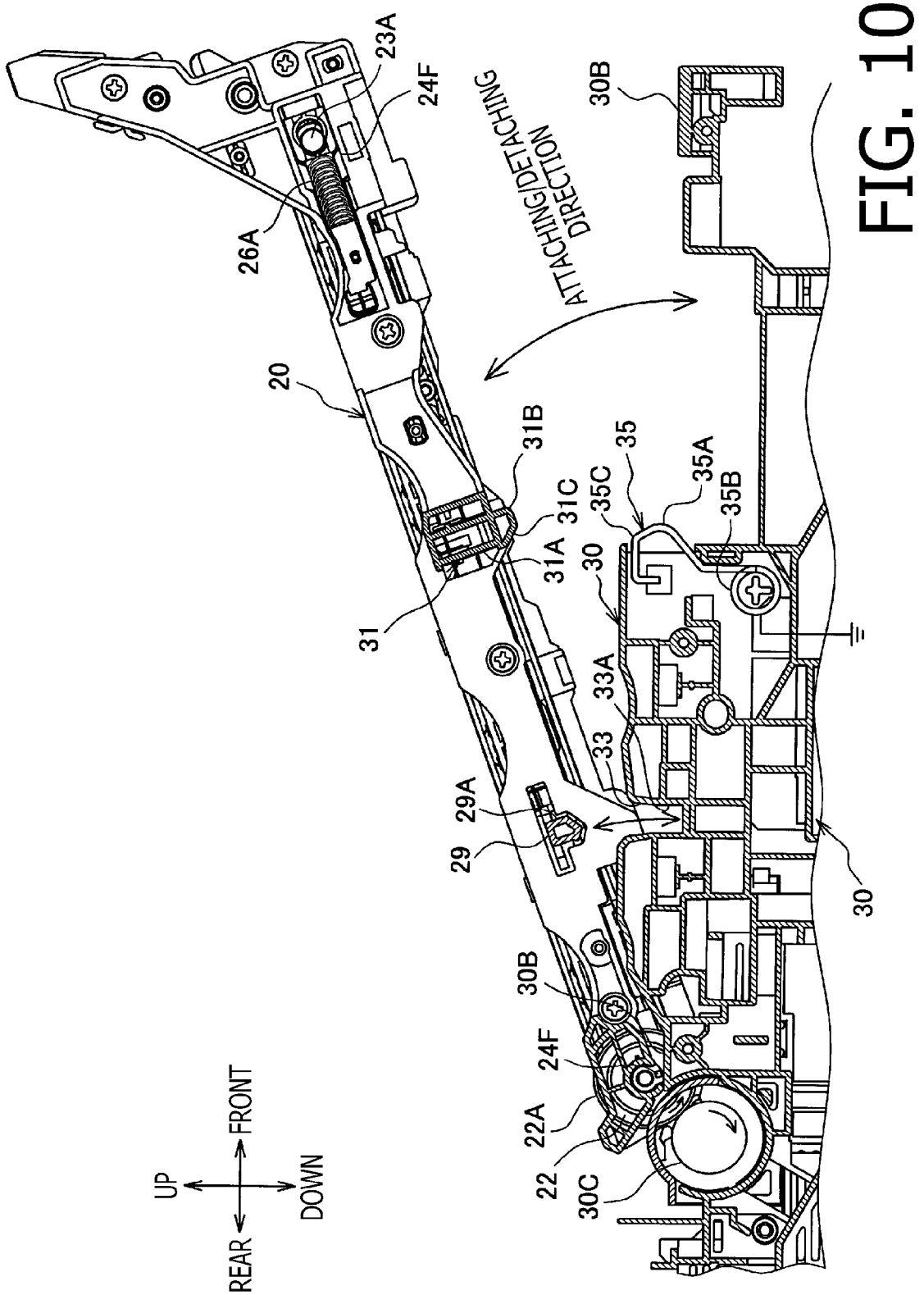

23A
24F
26A
20
ATTACHING/DETACHING DIRECTION
30B
31B
31C
35
35C
35A
35B
31A
30
31
33A
33
29A
29
30
30B
24F
22A
22
30C
UP
FRONT
REAR
DOWN

FIG. 10

IMAGE FORMING APPARATUS

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority from Japanese Patent Application No. 2012-119849, filed on May 25, 2012, the entire subject matter of which is incorporated herein by reference.

BACKGROUND

1. Technical Field

An aspect of the present invention relates to an image forming apparatus with a belt unit capable of forming an image on a sheet.

2. Related Art

An image forming unit may be equipped with a belt unit, which is detachably attached to the image forming apparatus.

Methods to form an image in the image forming apparatus with the belt unit may include, for example, a direct method and an intermediate-transferring method. In the direct method, the image may be formed directly on a sheet which is conveyed on an endless belt in the belt unit. In the intermediate-transferring method, the image may be formed on an endless belt in the belt unit and transferred onto a sheet being conveyed.

SUMMARY

In either method, when the endless belt is not in a relatively correct position with respect to an image forming unit installed in a main body of the image forming apparatus, the image may not be correctly formed in a correct position on the sheet.

The present invention is advantageous in that an image forming apparatus with a belt unit, which is capable of forming an image on a sheet correctly, is provided.

According to an aspect of the present invention, an image forming apparatus is provided. The image forming apparatus includes an image forming unit attached to a body of the image forming apparatus and configured to form an image on a sheet; a belt unit detachably attached to the body of the image forming apparatus, while the belt unit includes a first roller and a second roller arranged to extend axially in parallel with each other along an axial direction; an endless belt strained around the first roller and the second roller; and a frame configured to support the first roller and a second roller rotatably. The image forming apparatus further includes a frame positioning member arranged in the belt unit and configured to define a position of the frame in the axial direction with respect to the body of the image forming apparatus; a first roller positioning member arranged in the belt unit and configured to define a position of the first roller in the axial direction with respect to the frame; a guiding member arranged in a position corresponding to the one of axial-end sides of the first roller along the axial direction in the endless belt and configured to protrude from a belt strip of the endless belt; and an engageable member arranged on the one of axial-end sides of the first roller in the belt unit and configured to restrict the endless belt from being moved in the axial direction by being engaged with the guiding member. The frame positioning member, the first roller positioning member, and the engageable member are arranged on the same axial-end side along the axial direction.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

FIG. **1** is a cross-sectional side view of an image forming apparatus **1** according to an embodiment of the present invention.

FIG. **2** is a top plan view of a belt unit **20** of the image forming apparatus **1** according to the embodiment of the present invention.

FIG. **3**A is a perspective view of the belt unit **20** of the image forming apparatus **1** according to the embodiment of the present invention. FIG. **3**B is an exploded view of a shaft support **26** for a driven roller **23** in the belt unit **20** according to the embodiment of the present invention.

FIG. **4** illustrates the belt unit **20** and a main frame **30** to hold the belt unit **20** in the image forming apparatus **1** according to the embodiment of the present invention.

FIG. **5** is a cross-sectional view of the belt unit **20** according to the embodiment of the present invention taken along a line B-B shown in FIG. **8**.

FIG. **6** is an enlarged cross-sectional view taken along the line B-B shown in FIG. **8** including a collar **27** on a lateral frame **24**A in the belt unit **20** according to the embodiment of the present invention.

FIG. **7** is a cross-sectional view of the belt unit **20** according to the embodiment of the present invention taken along a line A-A shown in FIG. **8**.

FIG. **8** is a side view of the belt unit **20** according to the embodiment of the present invention.

FIG. **9** is a side view of the belt unit **20** attached to the main frame **30** of the image forming apparatus **1** according to the embodiment of the present invention.

FIG. **10** illustrates the belt unit **20** in an attaching/detaching position in the main frame **30** of the image forming apparatus **1** according to the embodiment of the present invention.

DETAILED DESCRIPTION

Hereinafter, an embodiment of the present invention will be described with reference to the accompanying drawings. It is noted that various connections are set forth between elements in the following description. These connections in general, and unless specified otherwise, may be direct or indirect, and this specification is not intended to be limiting in this respect.

1. Overall Configuration of Image Forming Apparatus

An overall configuration of an image forming apparatus **1** according to the embodiment will be described with reference to FIG. **1**. The image forming apparatus **1** being a multicolor electro-photographic image forming apparatus includes a chassis **3**, which accommodates an image forming unit **5** inside. The image forming unit **5** is configured to transfer an image, which is formed in a developer agent, onto a sheet (unsigned) of recording paper in an electro-photographic method. The image forming unit **5** includes a processing unit **7**, an exposure unit **9**, and a fixing unit **11**.

The image forming apparatus **5** is a direct tandem-typed image forming unit, in which a plurality of (e.g., four) processing units **7** align along a sheet conveying route.

Each of the processing units **7** contain a developer agent therein, and colors of the developer agents are different from one another. Other than the colors of the contained developer agents, the processing units **7** are configured identically to one another. Each processing unit **7** includes a photosensitive drum **7**A, on which an image in the developer agent is formed, and a charger **7**B to electrically charge the photosensitive drum **7**A.

In a position opposite from the photosensitive drums **7**A, across a transfer belt **21**, transfer units **15**, each of which includes a roller to transfer the developer agents carried on the photosensitive drums **7**A to the sheet, are disposed. The developer agents carried on the photosensitive drums **7**A are transferred to the sheet while the sheet is conveyed on the transfer belt **21**.

To each transfer unit **15**, electric voltage to transfer the developer agent from the photosensitive drum **7**A to the sheet is applied. Therefore, in order to remove the electric voltage from the transfer unit **15** after transferring the developer agent, a brush or saw-teeth shaped neutralizer **21**D (see FIG. **2**) is arranged in the vicinity of each transfer unit **15**. The transfer units **15**, the neutralizers **21**D, and the transfer belt **21** are arranged in the belt unit **20**. Detailed configuration of the belt unit **20** will be described later.

A feeder tray **6** is disposed in a lower position with respect to the belt unit **20**. The feeder tray **6** accommodates stacked sheets therein, and the sheets are picked up and conveyed one-by-one toward the image forming unit **5** by a feeder unit **8**. The feeder tray **6** is removable from a main body of the image forming apparatus **1**.

2. Belt Unit

2.1 Configuration of the Belt Unit

As shown in FIG. **2**, the belt unit **20** includes the transfer belt **21**, a driving roller **22**, a driven roller **23**, and a frame assembly **24** to hold the driving roller **22** and the driven roller **23**.

The transfer belt **21** is an endless belt arranged in a strained condition to roll around the driving roller **22** and the driven roller **23** along with rotation of the driving roller **22** and the driven roller **23**. The driving roller **22** is a roller to circulate the transfer belt **21**, and the driven roller **23** is rotated by the driving roller **22** along with the circulation of the transfer belt **21**. The endless belt denotes a belt which has no end along a rolling direction and can be circulated around the rollers endlessly.

The frame assembly **24** includes lateral frames **24**A, **24**B, which are arranged on axial (left and right) sides of the driving roller **22** along an axial direction to extend in parallel with a strained direction of the transfer belt **21**. The strained direction denotes a direction of tensile force, which is produced in a strained surface **21**A of the transfer belt **21** when the transfer belt **21** is installed in the frame assembly **24**. The strained surface **21**A denotes a surface of the transfer belt **21** which faces the photosensitive drums **7**A when the belt unit **20** is installed in the image forming apparatus **1**. In the present embodiment, the axial direction coincides with a widthwise (right-left) direction of the image forming apparatus **1** and includes a direction of an axis of the driving roller **22** and a direction of an axis of the driven roller **23**. Meanwhile, an axial-end side along the axial direction denotes an area closer to an axial end of the driving roller **22** or the driven roller **23** with respect to a widthwise center of image forming apparatus **1** along the axial direction. In the following description, one of the axial-end sides denotes a left-hand side along the axial direction with respect to the widthwise center, and the other of the axial-end sides denotes a right-hand side along the axial direction with respect to the widthwise center.

As shown in FIG. **3**, the lateral frames **24**A, **24**B are fixed in the frame assembly **24** by a fastening means such as screws (unsigned). On one of longitudinal ends of the lateral frame **24**A closer to the driven roller **23** and on one of longitudinal ends of the lateral frame **24**B closer to the driven roller **23**, a gripper frame **24**C extending along the axial direction to bridge between the lateral frames **24**A, **24**B are attached.

The gripper frame **24**C includes a gripper **24**D, by which the belt unit **20** is gripped, while the belt unit **20** is detachably attached to a main frame **30** (see FIG. **4**) in the chassis **3** of the image forming apparatus **1**. A user of the image forming apparatus **1** may grip onto the gripper **24**D when the user attaches and removes the belt unit **20** to and from the image forming apparatus **1**.

The main frame **30** of the image forming apparatus **1** includes a paired frames, which are arranged on both axial (right and left) sides of the chassis **3** along the axial direction. Therefore, the belt unit **20** is installed in the image forming apparatus **1** to bridge between the paired main frame **30** on the right and left sides along the axial direction. In the following description, unless otherwise noted, "the main frame **30**" denotes one of the paired main frames **30** closer to the lateral frame **24**A.

The lateral frame **24**A is formed to have frame positioning members **25**A (see FIG. **3**). The frame positioning members **25**A are engageable with one of in-body positioning members **30**A (see FIG. **4**), which are arranged in the main frame **30**. Thus, with the frame positioning members **25**A being engaged with the in-body positioning members **30**A, the lateral frame **24**A can be set in a correct position in the axial direction within the image forming apparatus **1** and with respect to the main frame **30**.

The frame positioning members **25**A include, as shown in FIG. **3**A, a pair of cylindrical protrusions, which protrude downward. Meanwhile, the in-body positioning members **30**A include, as shown in FIG. **4**, a pair of openings, in which the frame positioning members **25**A can be inserted.

Each of the in-body positioning member **30**A is formed to have an oval shape, in which a direction of a minor axis thereof coincides with the axial direction, and a direction of major axis thereof coincides with the strained direction. A dimension of the minor axis of the oval is substantially equal to an outer diameter of the frame positioning member **25**A.

Thus, by placing the frame positioning members **25**A inserted in the in-body positioning members **30**A, the belt unit **20** can be placed in the correct position in the axial direction. Meanwhile, the image forming apparatus **1** has a resilient member (not shown), which urges the belt unit **20** toward the lateral frame **24**A, on the lateral frame **24**B.

The driving roller **22** is rotatably held by the lateral frames **24**A, **24**B at axial ends thereof in a fixed position with respect to the lateral frames **24**A, **24**B. A roller gear **22**A (see FIG. **2**), which rotates along with the driving roller **22**, is arranged on one of the axial-end sides of the driving roller **22** along the direction.

Meanwhile, on the main frame **30**, a driving gear **30**C (see FIG. **4**) is arranged. The driving gear **30**C is engaged with the roller gear **22**A and supplies driving force to the driving roller **22**. The driving gear **30**C is rotated by rotating force supplied from an electric motor (not shown).

The driven roller **23** is rotatably held by the lateral frames **24**A, **24**B at axial ends thereof and is movable in the strained direction. In other words, as shown in FIG. **3**B, shafts **24**A of the driven roller **23** are rotatably held in shaft supports **26** at the axial ends thereof. The shaft supports **26** are attached to the lateral frames **24**A, **24**B and movable in the strained direction.

On each of the lateral frames **24**A, **24**B, a resilient member **26**A such as a coil spring is arranged. The resilient member **26**A provides resilient force, which is in a direction from the driving roller **22** toward the driven roller **23**, and applies the resilient force to the shaft support **26**. Thus, the driven roller **23** generates predetermined intension of tensile force in the strained surface **21**A.

The shaft support **26** is formed to have a shaft hole **26**B. The shaft hole **26**B is an opening, of which inner circumference is formed to slidably contact an outer circumference of a shaft **23**A of the driven roller **23**. In particular, the shaft hole **26**B is formed to have a cross-sectional shape of a smaller diameter circle and a larger diameter circle partly merged together, while a curvature radius of the smaller diameter circle is substantially equal to a curvature radius of the shaft **23**A, and a curvature radius in the larger diameter circle is greater than the curvature radius of the shaft **23**A. The smaller-diameter circular section is formed in a position closer to the driving roller **22**, while the larger-diameter circular section is formed in a position farther from the driving roller **22** along the strained direction.

The shaft support **26** includes, as shown in FIG. **5**, a tubular section **26**C, in which a shaft hole **26**B is formed, and a positioning section **26**D, which is formed on an outer periphery of the tubular section **26**C. The positioning section **26**D is formed to have protrusions, and in between the protrusions along the axial direction, a rail **24**E is interposed.

The rail **24**E is formed in each of the lateral frames **24**A, **24**B. The rail **24**E is a linearly formed protrusion extending along the strained direction, and the positioning section **26**D having the paired protrusions is in slidably contact with lateral faces of the rail **24**E. The lateral faces of the rail **24**E refer to surfaces which are orthogonal to the axial direction. With the rail **24**E slidably interposed in between the protrusions of the positioning section **26**D, the shaft support **26** is placed in a correct position with respect to the lateral frames **24**A, **24**B.

The driven roller **23** is formed to be smaller in a diameter at a dent **23**B, which dents inward along an entire outer periphery of the driven roller **23**, as shown in FIG. **6**. The dent **23**B is formed in a shaft of the driven roller **23** on one of the axial-end sides with the lateral frame **24**A (e.g., the left-hand side). The dent **23**B is slidably in contact with an inner circumference of the tubular section **26**C, i.e., the smaller-diameter circular section, in the shaft hole **26**B.

The dent **23**B is an inwardly-dented groove, which is formed to have a cross-sectional shape of a three-sided concave having lateral faces **23**C at axial ends along the axial direction and a bottom surface **23**D on a level closer to a central axis L**1**. While the inner circumference of the tubular section **26**C, i.e., the smaller-diameter circular section, is in slidably contact with the bottom surface **23**D, the shaft **23**A is rotatably supported by the shaft support **26**.

While an end **26**E of the tubular section **26**C along the axial direction is in slidably contact with the lateral face **23**C of the dent **23**B, the shaft **23**A is placed in a correct position in the axial direction with respect to the shaft support **26**. In other words, the dent **23**B defines a correct position of the driven roller **23** in the axial direction with respect to the shaft support **26**.

Further, the position of the shaft support **26** with respect to the lateral frame **24**A along the axial direction is defined by the positioning section **26**D. Thus, the dent **23**B serves to place the driven roller **23** in the correct position in the axial direction with respect to the lateral frame **24**A. In other words, the position of the driven roller **23** in the axial direction is defined with reference to the lateral frame **24**A.

Meanwhile, the transfer belt **21** includes a guided part **21**C, which protrudes inwardly from a belt strip **21**B, in a position corresponding to one of axial-end sides (e.g., a left-hand side) of the belt strip **21**B. More specifically, the guided part **21**C is a linearly-formed protrusion extending in the strained direction at a widthwise end (e.g., a leftward) position along an inner circumferential surface of the belt strip **21**B.

In the belt unit **20**, on the other hand, an engageable part **27**A is arranged on one of the axial-end sides (e.g., the left-hand side) of the driven roller **23** along the axial direction. With the guided part **21**C of the transfer belt **21** engaged with in the engageable part **27**A, the transfer belt **21** is restricted from moving in the axial direction.

The engageable part **27**A is formed in a circular shape to circle about the central axis L**1** of the shaft **23**A. With the guided part **21**C of the transfer belt **21** being set in the engageable part **27**A, the transfer belt **21** is restricted from moving in the axial direction.

The engageable part **27**A is formed in a collar **27**, which is rotatable independently from the driven roller **23**. The collar **27** is formed to have a tubular body **27**B, in which a shaft hole is formed. In the shaft hole of the tubular body **27**B, the shaft **23**A is inserted, and the outer circumference of the shaft **23**A is slidable with the shaft hole.

The engageable part **27**A is formed on the outer circumference of the tubular body **27**B of the collar **27**. Further, a collar positioning member **27**C to define a position of the collar **27** in the axial direction is formed at an axial end of the tubular body **27**B along the axial direction.

In particular, the tubular body **27**B of the collar **27** is interposed in between the shaft support **26** and a larger diameter section **23**E of the driven roller **23** along the axial direction. In this regard, the collar **27** is placed in a correct position in the axial direction by having the collar positioning member **27**C closer to the shaft support **26** to contact the tubular section **26**C of the shaft support **26**, and by having the collar positioning member **27**C closer to the larger diameter section **23**E of the driven roller **23** to contact the larger diameter section **23**E.

Thus, the shaft support **26** is placed in a correct position with respect to the lateral frame **24**A by the positioning section **26**D of the shaft support **26**. The driven roller **23** is placed in a correct position with respect to the lateral frame **24**A indirectly by the dent **23**B being placed in the correct position with respect to the shaft support **26**. The collar **27**, in particular, the engageable part **27**A, is placed in a correct position with respect to the lateral frame **24**A indirectly by the engageable part **27**A being placed in the correct position with respect to the shaft support **26** and the driven roller **23**.

It is noted, in the present embodiment, that the frame positioning member **25**A, the dent **23**B to define the position of the driven roller **23** in the axial direction, and the engageable part **27**A, are arranged on the side of the lateral frame **24**A along the axial direction.

Meanwhile, in the belt unit **20**, bearings **28** to define the position of the driving roller **22** in the axial direction with respect to the lateral frame **24**A are provided. In particular, as shown in FIG. **7**, on each axial end of the driving roller **22**, the bearing **28**, which rotatably supports a shaft **22**B of the driving roller **22**, is arranged.

One of the bearings **28** on the one side (e.g., the left-hand side) along the axial direction closer to the roller gear **22**A is attached to the lateral frame **24**A. On the other hand, the other of the bearings **28** on the other side (e.g., the right-hand side) along the axial direction is attached to the lateral frame **24**B. In the following description, unless otherwise noted, "the bearing **28**" denotes one of the paired bearings **28** attached to the lateral frame **24**A.

The shaft **22**B of the driving roller **22** penetrates the roller gear **22**A, and an open end of the shaft **22**B is rotatably supported by a bearing **28**A being attached to the lateral frame **24**A. Therefore, the part of the shaft **22**B, which penetrates

the roller gear **22**A, supports the roller gear **22**A from both right and left sides along the axial direction by the bearing **28** and the bearing **28**A.

The bearing **28**A is formed in a shape of a hat, including a tube **28**B and a flange **28**C. An inner circumference of the tube **28**B slidably contacts an outer circumference of the shaft **22**B. The flange **28**C is formed at an axial end of the tube **28**B on a side closer to the roller gear **22**A.

With the flange **28**C being in contact with the lateral frame **24**A, the bearing **28**A is placed in a correct position in the axial direction with respect to the lateral frame **24**A. Further, with the bearing **28**A being in contact with the roller gear **22**A, the roller gear **22**A is placed in a correct position in the axial direction with respect to the bearing **28**A. Thus, the roller gear **22**A is placed in a correct position in the axial direction with respect to the lateral frame **24**A via the bearing **28**A.

A pin **22**C penetrates the shaft **22**B to be engaged with the roller gear **22**A and conveys rotation force transmitted to the roller gear **22**A to the shaft **22**B. With the pin **22**C being in contact with the roller gear **22**A, the shaft **22**B is placed in a correct position in the axial direction with respect to the roller gear **22**A. Thus, the driving roller **22** is placed in a correct position in the axial direction with respect to the lateral frame **24**A via the bearing **28**A, the roller gear **22**A, and the pin **22**C.

While the driving roller **22** is in the correct position in the axial direction via the bearing **28**A, the roller gear **22**A, and the pin **22**C, the driving roller **22** is restricted from being moved toward the one of the axial-end sides along the axial direction (e.g., leftward in FIG. **7**). Further, while the driving roller **22** is in the correct position in the axial direction via the bearing **28** and the pin **22**C being in contact with each other, the driving roller **22** is restricted from being moved toward the other of the axial-end sides along the axial direction (e.g., rightward in FIG. **7**).

The lateral frame **24**A has a first contiguous part **29** and a pressed part **31**, as shown in FIG. **8**. The first contiguous part **29** is a protrusion, which protrudes from the lateral frame **24**A toward the main frame **30** (e.g., leftward), and is formed integrally with the lateral frame **24**A in a resin.

Meanwhile, as shown in FIG. **9**, the main frame **30** is formed to have a first contact section **33** being a dent, in which the protrusive first contiguous part **29** can be caught. When the first contiguous part **29** is caught in the first contact section **33**, a first contacting edge **33**A of the first contact section **33**, which is an edge closer to the pressed part **31** (see FIG. **10**), and a first contiguous edge **29**A of the first contiguous part **29**, which is an edge closer to the pressed part **31**, become in contact with each other along the strained direction (see FIG. **9**).

The pressed part **31** is a protrusion, which protrudes from the lateral frame **24**A toward the main frame **30** (e.g., leftward in FIG. **3**), as shown in FIG. **3**. The pressed part **31** is arranged in a position to be closer to the driven roller **23** with respect to the first contiguous part **29** (e.g., displaced frontward from the first contiguous part **29** in FIG. **3**) along the strained direction.

The pressed part **31** includes a protrusion **31**B, which is integrally formed with the lateral frame **24**A, and a metal-made pressed edge **31**A, which covers at least an edge of the protrusion **31**B closer to the first contiguous part **29**. The pressed edge **31**A is connected with each of the neutralizers **21**D via electrical wires **21**E (see FIG. **2**).

Meanwhile, the main frame **30** has a pressing member **35** (see FIG. **9**). The pressing member **35** contacts the pressed edge **31**A to press the pressed part **31** toward the driven roller **23** when the belt unit **20** is attached to the main frame **30**, and when the first contiguous part **29** is caught in the first contact section **33**. The pressing member **35** is a metal-made spring, which is resiliently deformable.

When the belt unit **20** is attached to the main frame **30**, and pressure F from the pressing member **35** is applied to the pressed part **31**, the first contiguous part **29** is pressed by the first contacting section **33** to increase contacting surface pressure between the first contacting edge **33**A and the first contiguous edge **29**A. Thus, the belt unit **20** is placed in a correct position with respect to the main frame **30** in the strained direction.

In this regard, the first contacting section **33**, the first contiguous part **29**, the pressing member **35**, and the pressed part **31** are arranged in positions to have a line L**2** (see FIG. **9**), which connects the contacting position between the first contacting section **33** and the first contiguous part **29** and the contacting position between the pressing member **35** and the pressed part **31**, to extend in parallel with the strained direction. A direction of the line L**2** connecting the two contacting positions will be hereinafter referred to as a positioning direction L**2**.

Further, the contacting position between the first contacting section **33** and the first contiguous part **29** refers to either an area, in which the contacting surface pressure is the greatest, or a central area, in range in which the first contacting section **33** and the first contiguous part **29** contact each other. Similarly, the contacting position between the pressing member **35** and the pressed part **31** refers to either an area, in which the contacting surface pressure is the greatest, or a central area, within a range in which the pressing member **35** and the pressed part **31** contact each other.

The pressing member **35** is electrically connected to the ground. Therefore, when the belt unit **20** is attached to the main frame **30**, and the pressed edge **31**A and the pressing member **35** contact each other, the neutralizers **21**D are grounded through the pressing member **35** and the pressed part **31**.

Each of the lateral frames **24**A, **24**B has a second contiguous section **24**F on each longitudinal end thereof along the longitudinal direction. Meanwhile, the main frame **30** has second contacting sections **30**B, which contact the second contiguous sections **24**F when the belt unit **20** is attached to the main frame **30**.

With the second contacting sections **30**B being in contact with the second contiguous sections **24**F, the belt unit **20** is placed in a correct position with respect to the main frame **30** in a direction orthogonal to the strained surface **21**A.

The direction orthogonal to the strained surface **21**A, according to the present embodiment, is a normal direction and coincides with a vertical direction. On the other hand, the strained direction coincides with a horizontal direction. Therefore, when the second contacting sections contact the second contiguous sections **24**F, the belt unit **20** is placed in a vertically correct position with respect to the main frame **30**.

2.2 Attachment and Detachment of the Belt Unit

As shown in FIG. **10**, the pressing member **35** includes a torsion coil spring, and a coiled end **35**B of the coil spring is fixed to the main frame **30**. With the coiled end **35**B fixed to the main frame **30**, the pressing member **35** is resiliently deformable, and the other end of the pressing member **35** being opposite from the coiled end **35** is swingable about the coiled end **35**B.

The pressing member **35** is formed to further have a contact part **35**A, which is formed in a triangular shape protruding toward the driven roller **23**, in a position between the coiled end **35**B and the other end. The contact part **35**A is contiguous with the pressed part **31** of the lateral frame **24**A. Furthermore, the pressing member **35** is formed to have a guiding

edge **35**C in a range closer to the belt unit **20** with respect to the contact part **35**. The guiding edge **35**C is formed to incline from a peak of the triangular shape of the contact part **35**A toward the driving roller **22** along an attaching/detaching direction (see FIG. **10**) of the belt unit **20**, as the pressing member **35** ascends to be closer to the belt unit **20**.

On the other hand, the pressed part **31** of the lateral frame **24**A is formed to have a guiding edge **31**C in a position closer to the pressing member **35** with respect to the pressed edge **31**A and between the pressed edge **31**A and the protrusion **31**B. The guiding edge **31**C is formed to incline from the pressed edge **31**A toward the driven roller **23** along the attaching/detaching direction of the belt unit **20**.

When the belt unit **20** is attached to the main frame **30**, as shown in FIG. **10**, while the second contiguous section **24**F closer to the driving roller **22** is placed to be in contact with the second contacting section **30**B, a front side of the belt unit **20**, which is a side closer to the driven roller **23**, is moved toward the main frame **30**, i.e., downward.

When the pressing member **35** and the pressed part **31** come into contact, the guiding edge **35**C of the pressing member **35** and the guiding edge **31**C of the pressed part **31** slidably contacts each other, and the pressing member **35** is resiliently deformed toward the driving roller **22**. Further, as shown in FIG. **9**, the first contiguous part **29** of the lateral frame **24**A is inserted in the first contacting section **33** of the main frame **30**.

When the first contiguous part **29** and the first contacting section **33** contact each other (see FIG. **9**), the pressing member **35** is resiliently deformed toward the driving roller **22** compared to the posture of the pressing member **35** when the first contiguous part **29** and the first contacting section **33** do not contact each other (see FIG. **10**). Thus, the pressure F is applied from the pressing member **35** to the pressed part **31**.

On the other hand, when the belt unit **20** is detached from the main frame **30**, the belt unit **20** is rotated about the second contiguous section **24**F, which is on a side closer to the driving roller **22**, upwardly to separate the front side with the driven roller **23** apart from the main frame **30** (see FIG. **10**).

3. Features of the Image Forming Apparatus with the Belt Unit

As has been described above, the frame positioning member **25**A, the dent **23**B, and the engageable part **27**A, are arranged on the same axial-end side, i.e., the left-hand side with the lateral frame **24**A, along the axial direction. Therefore, the driven roller **23** is positioned with reference to the same axial-end side along the axial direction as the belt unit **20**. Further, the transfer belt **21** is restricted from being moved in the axial direction on basis of the same axial-end side as the driven roller **23**.

Accordingly, the relative position of the transfer belt **21** with respect to the image forming unit **5** falls within a range of tolerances accumulated based on the position of the lateral frame **24**A. Generally, when tolerances accumulated based on different positions and tolerances accumulated on one position are compared, even if the parts and components belong to a same level of tolerance class, while a basic dimension for the tolerances accumulated on the one position is smaller than basic dimensions for the tolerances accumulated on different positions, the tolerances accumulated on the one position is summed to be smaller than the tolerances accumulated on the different positions.

In this regard, the tolerance class denotes a group of tolerances which belong to a same accuracy level with respect to a basic dimension. When the accuracy level for each component is toughened, a quantity of manufacturing process increases, and manufacturing costs tend to be increased.

Meanwhile, according to the present embodiment, without relaxing the accuracy level of the tolerance class for each component largely, the relative position of the transfer belt **21** with respect to the image forming unit **5** can be maintained within the tolerated range. Thus, the image may be formed in a correct position on the sheet.

More Examples

Although an example of carrying out the invention has been described, those skilled in the art will appreciate that there are numerous variations and permutations of the belt unit and the image forming apparatus that fall within the spirit and scope of the invention as set forth in the appended claims. It is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or act described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

For example, the dent **23** in the shaft **23**A to define the position of the driven roller **23** in the axial direction may not necessarily be the concave, but the position of the driven roller **23** in the axial direction may be defined by a protrusion formed on the outer circumference of the shaft **23**A.

For another example, the guided part **21**C may not necessarily be a seamless strip of protrusion, which is continuously arranged on the inner peripheral surface of the belt strip **21**B. For example, a toothed belt, on which smaller protrusions are intermittently arranged, may be employed.

For another example, the collar **27** may not necessarily be rotatable independently from the driven roller **23** but may be rotatable integrally along with the driven roller **23**. Alternatively, the driven roller **23** may be formed to have the engageable part **27**A.

For another example, the frame positioning member **25**A, the dent **23**B, and the engageable part **27**A, may not necessarily be arranged on solely one of the axial-end sides along the axial direction but may be arranged on the both axial-end sides along the axial direction.

Further, the frame positioning member **25**A, the dent **23**B, and the engageable part **27**A, may not necessarily be in the shapes as described above or illustrated in the accompanying drawings.

For another example, one or more additional rollers may be provided in addition to the driving roller **22** and the driven roller **23**.

For another example, the present invention may not necessarily be applied to the direct-typed image forming apparatus but may be similarly applied to an intermediate transfer-typed image forming apparatus.

For another example, the exposure unit **9** provided to each of the photosensitive drums **7**A may not necessarily be equipped with the plurality of LEDs aligned along the axial direction of the photosensitive drum **7**A. The exposure unit **9** may be a so-called scanner-typed exposure unit, in which a laser beam scans the circumference of the photosensitive drum **7**A along the axial direction.

What is claimed is:

1. An image forming apparatus, comprising:

an image forming unit attached to a body of the image forming apparatus and configured to form an image on a sheet;

a belt unit detachably attached to the body of the image forming apparatus, the belt unit comprising:

a first roller and a second roller arranged to extend axially in parallel with each other along an axial direction;

an endless belt extending around the first roller and the second roller; and

a frame configured to rotatably support the first roller and the second roller;

a frame positioning member arranged in the belt unit and configured to define a position of the frame in the axial direction with respect to the body of the image forming apparatus;

a first roller positioning member arranged in the belt unit and configured to define a position of the first roller in the axial direction with respect to the frame;

a guiding member arranged in a position corresponding to an axial-end side of the first roller along the axial direction in the endless belt and configured to protrude from a belt strip of the endless belt; and

an engageable member arranged on the axial end side of the first roller in the belt unit and configured to restrict the endless belt from being moved in the axial direction by engaging with the guiding member,

wherein the frame positioning member, the first roller positioning member, and the engageable member are arranged on the same axial-end side along the axial direction, and

wherein the first roller positioning member includes a concave groove formed on the axial-end side of the first roller.

2. The image forming apparatus according to claim **1**,

wherein the frame positioning member, the first roller positioning member, and the engageable member are arranged solely on the same axial-end side along the axial direction.

3. The image forming apparatus according to claim **1**,

wherein the engageable member is arranged in a collar, the collar being rotatable independently from the first roller, and

wherein the collar comprises a collar positioning member, the collar positioning member configured to define a position of the collar in the axial direction with respect to the frame.

4. The image forming apparatus according to claim **1**, further comprising:

a bearing configured to support the first roller rotatably; and

a bearing positioning member configured to define a position of the bearing in the axial direction with respect to the frame,

wherein the first roller positioning member is configured to define the position of the first roller in the axial direction with respect to the frame by defining a position of the first roller in the axial direction with respect to the bearing.

5. The image forming apparatus according to claim **1**, further comprising:

a second roller positioning member configured to define a position of the second roller in the axial direction with respect to the frame,

wherein the second roller positioning member is arranged on the same axial-end side along the axial direction as the first roller positioning member.

6. The image forming apparatus according to claim **1**,

wherein the second roller is a driving roller configured to circulate the endless belt, and

wherein the first roller is a driven roller configured to be rotated along with circulation of the endless belt.

* * * * *